

Docket No. 12732-016001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of)
Shunpei YAMAZAKI et al.)
Serial No.: 09/783,426)
Filed: February 15, 2001)
For: EL DISPLAY DEVICE AND)
ELECTRONIC DEVICE)

VERIFICATION OF TRANSLATION



Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

I, Satomi Yumoto, B-310, 304-1, Hase, Atsugi-shi, Kanagawa-ken 243-0036 Japan, a translator, herewith declare:

that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached translation of the above identified application Serial No. 09/783,426 filed on February 15, 2001; and

that to the best of my knowledge and belief the following is a true and correct translation of the above identified application Serial No. 09/783,426 filed on February 15, 2001.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 5 day of July, 2001


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It is understood that this perfects the application and no additional papers or filing fees are required. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

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[Document Name] Specification

[Title of the Invention] EL DISPLAY DEVICE AND ELECTRONIC
DEVICE

[Scope of Claim]

[Claim 1]

An EL display device characterized by comprising a substrate on which an EL element is formed, a cover member, a filler for adhering said substrate on which the EL element is formed to said cover member, a sealing member for covering a side surface of said filler, and a frame member adhered with said sealing member.

[Claim 2]

An EL display device characterized by comprising an active matrix substrate on which a TFT and an EL element electrically connected with the TFT are formed, a cover member, a filler for adhering said active matrix substrate to said cover member, a sealing member for covering a side surface of said filler, and a frame member adhered with said sealing member.

[Claim 3]

An EL display device characterized by comprising a substrate on which an EL element composed of an anode arranged in stripe, a cathode arranged in stripe so as to be perpendicular to said anode, and an EL layer between said

anode and said cathode is formed, a cover member, a filler for adhering said substrate on which the EL element is formed to said cover member, a sealing member for covering a side surface of said filler, and a frame member adhered with said sealing member.

[Claim 4]

An EL display device as claimed in any one of claims 1 to 3, characterized in that a drying agent is included in said filler.

[Claim 5]

An EL display device as claimed in any one of claims 1 to 3, characterized in that said cover member is provided with a light shielding film or color filter.

[Claim 6]

An EL display device as claimed in claim 5, characterized in that a drying agent is included in said light shielding film or color filter.

[Claim 7]

An EL display device as claimed in claim 4 or claim 6, characterized in that said drying agent is barium oxide.

[Claim 8]

An EL display device as claimed in claim 4 or claim 6, characterized in that said drying agent has a granular shape with an average diameter of 100 μm , and is included with a

density of 1×10^2 to 1×10^5 atoms/cm³.

[Claim 9]

An electronic device characterized by using the EL display device according to any one of claims 1 to 8 in a display portion thereof.

[Claim 10]

A portable telephone characterized by using the EL display device according to any one of claims 1 to 8 in a display portion thereof.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention belongs]

The present invention relates to an EL (electroluminescence) display device and an electronic device using the display device, and more specifically, relates to a technique for preventing deterioration of an EL element.

[0002]

[Prior Art]

In recent years, development of a display device using an EL element as a self-light emitting element that utilizes an EL phenomenon of an organic material (EL display device) is being progressed. The EL display device is a self-light emitting type, and thus, does not need a back light unlike a liquid crystal display device. Further, the EL display device

has a wide viewing angle, and therefore, is promising as a display portion of a portable device used outdoors.

[0003]

However, since an EL layer that is a base of the EL element is formed from an organic material, the EL layer is very weak to oxidization and easily deteriorates due to the existence of a small amount of oxygen. Further, the EL layer is weak to heat, and this also becomes the cause to promote oxidization. The drawback that the EL layer is weak to oxidization is the cause of shortness of life of the EL element and has been a big obstacle to putting the EL display device to practical use.

[0004]

[Problems to be solved by the Invention]

An object of the present invention is to provide an EL display device with high reliability. Further, another object of the present invention is to provide an electronic device using such an EL display device with high reliability as its display portion.

[0005]

[Means to solve the Problem]

A structure of the present invention is explained with reference to Fig. 1. Fig. 1A shows an EL display device of the present invention in a state that a sealing structure for

sealing an EL element in a sealing space is not provided.

[0006]

In Fig. 1A, reference numeral 101 indicates a substrate, 102 indicates a pixel portion, 103 indicates a source side driver circuit, 104 indicates a gate side driver circuit, and 105 indicates a connection wiring for electrically connecting the pixel portion 102, the source side driver circuit 103, and the gate side driver circuit 104 to a flexible printed circuit (FPC) 106. Further, the FPC is electrically connected to an external apparatus, whereby a signal from the outside can be input to the pixel portion 102, the source side driver circuit 103, and the gate side driver circuit 104.

[0007]

The pixel portion 102, the source side driver circuit 103, and the gate side driver circuit 104 are formed of thin film transistors (hereinafter referred to as TFTs) formed on the substrate 101. Note that TFTs having any structure may be used as the TFTs. Of course, the TFTs may adopt a known structure.

[0008]

Fig. 1B shows a state that the sealing structure is provided in the state of Fig. 1A. The sealing structure of the present invention includes a filler (not shown), a cover member 107, a sealing member (not shown), and a frame member 108.

[0009]

Here, the cross-sectional view taken along with a line A-A' of Fig. 1B and the cross-sectional view taken along with a line B-B' of Fig. 1B are shown in Fig. 2A and Fig. 2B, respectively. In Figs. 2A and 2B, the same reference numerals are used for the same portions as in Figs. 1A and 1B.

[0010]

As shown in Fig. 2A, the pixel portion 102 and the driver circuit 103 are formed on the substrate 101, and the pixel portion 102 is formed by a plurality of pixels each including a current control TFT 201 and a pixel electrode 202 electrically connected therewith. This pixel electrode 202 functions as an anode of an EL element. Further, an EL layer 203 is formed so as to cover the pixel electrode 202, and a cathode 204 of the EL element is formed thereon.

[0011]

Note that, in this specification, an element composed of an anode/an EL layer/a cathode is referred to as an EL element. In actuality, an electric current is made to flow between the anode and the cathode, and an electron and a hole are recombined in the EL layer, thereby obtaining light emission.

[0012]

Further, there is no particular limitation on the structure of the EL element in the present invention.

Generally, a film having a large work function, for example, a transparent conductive film is used as the anode, and a film having a small work function, for example, a film containing alkali metal or alkaline-earth metals is used as the cathode. In addition, the EL layer can adopt any known structure.

[0013]

Note that, in this specification, the EL layer refers to a layer that provides the place for transfer, transportation, or recombination of carriers, which is located between the anode and the cathode. There may be a case where the EL layer is comprised of only a light-emitting layer that becomes the center of recombination. However, the light emitting layer in combination with an electron injecting layer, an electron transporting layer, a hole injecting layer, and a hole transporting layer is generally used.

[0014]

Further, there are inorganic materials and organic materials for a material forming the EL layer. The organic materials sufficed with a small driving voltage are preferable. Further, there are low molecular weight materials and high molecular weight (polymer) materials in the organic materials. The high molecular weight materials are effective in terms of high heat-resistance and easy film deposition.

[0015]

Incidentally, the pixel portion 102 and the driver circuit 103 are simultaneously formed. The driver circuit 103 is formed by a CMOS circuit as a base unit, in which an n-channel TFT 205 and a p-channel TFT 206 are complementarily combined, in many cases.

[0016]

Further, the cathode 204 also functions as a common wiring to all the pixels, and is electrically connected with the FPC 106 through the connection wiring 105. Besides, all the elements included in the pixel portion 102 and the driver circuit 103 are covered by a passivation film 207. The passivation film 207 can be omitted, but it is preferable to provide the film in order to shut the respective elements from the outside.

[0017]

Next, a filler 208 is provided so as to cover the EL element. This filler 208 functions also as an adhesive for adhering the cover member 107. As the filler 208, a PVC (polyvinyl chloride), an epoxy resin, a silicone resin, a PVB (polyvinyl butyral), or an EVA (ethylene vinyl acetate) can be used. It is preferable that a drying agent is provided inside the filler 208, thereby being capable of maintaining a moisture absorbing effect.

[0018]

Further, as the cover member 107, a glass plate, an aluminum plate, a stainless plate, an FRP (fiberglass-reinforced plastics) plate, a PVF (polyvinyl fluoride) film, a mylar film, a polyester film, or an acrylic film may be used. Note that, in the case where PVB or EVA is used as the filler 208, it is preferable to use a sheet having a structure in which an aluminum foil with a thickness of several tens of μm is sandwiched by the PVF film or the mylar film.

[0019]

Note that the cover member 107 may need to have a light transmitting property depending on a light emission direction (light radiation direction) from the EL element. Namely, since light is radiated to the side opposite to the cover member 107 in case of Fig. 2, it does not matter what material is used for the cover member 107. However, in the case where light is radiated to the cover member 107 side, it is preferable that the cover member 107 is formed from the material having high transmissivity.

[0020]

Next, after the cover member 107 is adhered using the filler 208, the frame member 108 is attached so as to cover a side surface (exposing surface) of the filler 208. The frame member 108 is adhered by a sealing member (functioning as an adhesive) 209. At this time, a photo curable resin is

preferably used as the sealing member 209, but a thermosetting resin may be used if the heat-resistance of the EL layer permits. Note that the sealing member 209 is preferably formed from a material that does not transmit moisture or oxygen as much as possible. Further, a drying agent may be added inside the sealing member 209.

[0021]

The EL element can be completely shut from the outside by sealing the EL element into the filler 208 with the above method, and the substances, which promote deterioration of the EL layer due to oxidization, such as moisture and oxygen can be prevented from permeating the EL element from the outside. Therefore, the EL display device with high reliability can be manufactured.

[0022]

[Embodiment Mode of the Invention]

Embodiment mode of the present invention is explained with reference to Fig. 3. Fig. 3 is a cross-sectional view of an EL display device of the present invention. Note that the basic structure is the same as Fig. 2A, and thus, the explanation is made as the need arises.

[0023]

In the EL display device of Fig. 3, a pixel portion 302 and a driver circuit 303 are formed by TFTs formed on a glass

substrate 301. Further, a current control TFT formed in the pixel portion 302 is electrically connected with an EL element 304. Note that, instead of the glass substrate, a quartz substrate, a silicon substrate, a stainless substrate, a plastic substrate (including a plastic film), or a ceramics substrate may be used. Note that an insulating film needs to be provided on the substrate depending on the situation.

[0024]

Further, in this embodiment mode, an EL layer containing a light emitting layer made from a high molecular weight organic material and an anode formed from a transparent conductive film common to respective pixels are formed on a pixel electrode (cathode) connected with the current control TFT, thereby obtaining the EL element. As the high molecular weight organic material, any known material may be used, or a lamination of low molecular weight organic materials may be used. Also, any known lamination structure may be adopted. In this embodiment mode, a white color light emitting layer is formed on the cathode in accordance with Japanese Patent Application Laid-open No. Hei 8-96959. As the transparent conductive film that becomes the anode, a compound of indium oxide and tin oxide, a compound of indium oxide and zinc oxide, tin oxide, or zinc oxide may be used.

[0025]

PVB is provided as a filler 305 on an active matrix substrate including the above structure, and barium oxide as a drying agent 306 is included in the filler 305. In addition to barium oxide, the substances described in Japanese Patent Application Laid-open No. Hei 9-148066 may be used. Further, the addition of the drying agent is not essential in the present invention, but is preferable in order to increase the reliability more.

[0026]

Note that the drying agent may be added in any form. However, dispersing the drying agent with a cluster shape may be the cause of dropping brightness of an image, and thus, the drying agent is preferably dispersed with a small granular shape as much as possible. The preferable state is such that the granular-shape drying agent with an average diameter of 100 μm or less is included with a density of 1×10^2 to 1×10^5 atoms/ cm^3 .

[0027]

A glass substrate as a cover member 307 is provided on the filler 305. In this embodiment mode, the cover member 307 needs to have a light transmitting property. This is because light emitted from the light emitting layer transmits the cover member 307 to reach an observer in accordance with the structure of the EL element. Of course, instead of the glass

substrate, a plastic substrate (including a plastic film), a quartz substrate, or a PVF film may be used as the cover member 307.

[0028]

Further, in this embodiment mode, the cover member 307 is provided with a light shielding film 308 and a color filter 309. A resin containing black pigment or carbon may be used for the light shielding film 308. Of course, a metal film such as a titanium film, a tantalum film, or a tungsten film may be used. Besides, a resin containing red, green, or blue pigment may be used for the color filter 309. A known method such as an ink jet method or a spin coating method may be used for a method of depositing the light shielding film 308 and the color filter 309.

[0029]

In this embodiment mode, a single layer of a white color light emitting layer is used as the EL element, and the white color light emitted from the layer is color-separated by the color filter to obtain colors of red, green and blue. Thus, color display is enabled. Note that a color display method usable in the present invention may be any known method. Further, not only color display but also monochrome display with single color emission is possible.

[0030]

Here, a method of adhering the cover member 307 using the filler 305 is described with reference to Fig. 4. The apparatus shown in Fig. 4 is a bonding apparatus of a system called a double vacuum system. This bonding apparatus has a first vacuum chamber 401 and a second vacuum chamber 402, and each of the chambers is provided with a first exhaust means 403, a second exhaust means 404, a first leak valve 405, and a second leak valve 406.

[0031]

Further, the second vacuum chamber 402 is provided with a heating means 407, and the temperature inside the first vacuum chamber 401 can be raised by resistance heating. Moreover, an active matrix substrate (substrate finished through the formation of the TFT and the EL element) 408, a PVB film 409, and a cover member 410 are arranged within the second vacuum chamber 402.

[0032]

Next, the inside of the first vacuum chamber 401 and the second vacuum chamber 402 is exhausted to form a vacuum. Then, the inside of the second vacuum chamber 402 is heated to approximately 120°C by the heating means 407 in this state, and thus, the PVB film 409 exhibits flowability. When the PVB film 409 shows the flowability, the leak valve 405 of the first vacuum chamber 401 is opened, and the inside of the first

vacuum chamber 401 is exposed to an atmosphere to be pressurized.

[0033]

When the first vacuum chamber 401 is pressurized, a diaphragm (formed of silicone, rubber or the like) that partitions the first vacuum chamber 401 and the second vacuum chamber 402 pressures the cover member 410 of the second vacuum chamber 402, and the active matrix substrate 408 and the cover member 410 are completely adhered by the filler 409. Thereafter, the second vacuum chamber 402 is returned to a room temperature, and exposed to the atmosphere by the leak valve 406. Note that the second vacuum chamber 402 may be forcedly cooled by circulating a cooling water or the like.

[0034]

As described above, a process of bonding the active matrix substrate to the cover member is conducted. Note that the double vacuum system is used in this embodiment mode, but a single vacuum system may also be used. Either technique is described in detail in "Solar Cell Handbook, Institute of Electrical Engineers of Japan, Investigation Committee of a Solar Cell(?) ed., pp. 165-166, 1985".

[0035]

In this way, the active matrix substrate and the cover member 307 are bonded to each other by the filler 305. Then, a

frame member 310 is adhered by the sealing member 309 to completely cover the end surface of the filler 305. In this embodiment mode, an ultraviolet ray curing epoxy resin is used as the sealing member 309, and a stainless material is attached as the frame member 310.

[0036]

The EL display device as shown in Fig. 3 is thus completed. Since moisture and oxygen do not permeate such an EL display device from the outside, deterioration of the EL layer can be prevented, and the life of the EL element is long. That is, the EL display device has very high reliability.

[0037]

[Embodiments]

[Embodiment 1]

In this embodiment, an example of using a PVF film as a cover member is shown in Fig. 5. In Fig. 5, reference numeral 501 indicates a light transmitting substrate (a plastic substrate in this embodiment), 502 indicates a pixel portion, 503 indicates a driver circuit, and the respective portions are formed of TFTs. Besides, an EL element 504 is formed in the pixel portion 502, and image display is performed.

[0038]

A cover member 507 is bonded onto an active matrix substrate finished through the formation of the EL element (or

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a passivation film thereon) through a filler 505 added with a drying agent 506. The bonding apparatus shown in Fig. 4 may be used in this bonding process. This cover member 507 has a structure in which PVF films 507a and 507b sandwich an aluminum foil 507c. The aluminum foil 507c is provided in order to increase moisture-resistance.

[0039]

Thereafter, a sealing member 508 made of an ultraviolet ray curing resin is used to attach a frame member 509. In this embodiment, a stainless material is used as the frame member 509. Finally, an FPC 510 is attached to complete an EL display device.

[0040]

[Embodiment 2]

In this embodiment, an example of implementing the present invention in a simple matrix EL display device is shown in Fig. 6. In Fig. 6, reference numeral 601 indicates a plastic substrate, and reference numeral 602 indicates a cathode with a lamination structure of an aluminum film and a lithium fluoride film (the lithium fluoride film corresponds to the portion contacting an EL layer). In this embodiment, the cathode 602 is formed by an evaporation method. Note that, although not shown in Fig. 6, a plurality of cathodes are arranged in stripe in a direction perpendicular to the paper.

arranged in stripe such that the direction perpendicular to the paper is a longitudinal direction and that the anode is perpendicular to the cathodes. Further, although not shown in the figure, a wiring line of the anode 604 is drawn out to the portion where an FPC is attached later so as to be applied with a predetermined voltage.

[0044]

After the anode 604 is formed, a silicon nitride film of 100 nm thickness is formed as a passivation film 605. This is a protective film for not making the EL layer 603 be exposed to an atmosphere in the later adhesion of a cover member and the like.

[0045]

As described above, an EL element is formed on the substrate 601. Next, a plastic plate is prepared as a cover member 606, and a light shielding film 607 and a color filter 608 are formed on the surface of the cover member 606. A resin containing carbon is used for the light shielding film 607, and a resin containing pigment corresponding to RGB is used for the color filter 608. An ink jet method, a spin coating method, or a printing method may be used for a film deposition method.

[0046]

Further, since the light emitted from the EL element

transmits the cover member 606 to enter observer's eyes with the structure in this embodiment, the cover member 606 has light transmitting property. The plastic plate is used in this embodiment, but a light transmitting substrate such as a glass plate, a PVF film (or a light transmitting film) may be used.

[0047]

When the cover member 606 is prepared in this way, the cover member 606 is bonded through a filler 610 added with a drying agent 609. In a bonding process, the bonding apparatus shown in Fig. 4 may be used. Thereafter, a frame member 612 is attached by using a sealing member 611 made of an ultraviolet ray curing resin. In this embodiment, a stainless material is used as the frame member 612. Finally, an FPC 613 is attached to complete an EL display device.

[0048]

[Embodiment 3]

In this embodiment, an example of implementing the present invention in a simple matrix EL display device is shown in Fig. 7. In Fig. 7, reference numeral 701 indicates a glass substrate, and reference numeral 702 indicates an anode made of a transparent conductive film. In this embodiment, a compound of indium oxide and tin oxide is formed by a sputtering method. Note that, although not shown in Fig. 7, a plurality of anodes are arranged in stripe in a direction

perpendicular to the paper.

[0049]

An insulating film (a silicon nitride film in this embodiment) 703 is formed on the anode 702 by photolithography, and a spacer 704 made of resin such as acrylic or polyimide is formed on the insulating film 703. The spacer 704 is formed so as to have an upside-down triangle shape. In order to obtain the upside-down triangle shape, the resin film that becomes the spacer may be provided with a lamination structure, and the film with a faster etching rate may be used for the lower layers. Further, the spacers 704 are formed in stripe with the direction perpendicular to the paper being a longitudinal direction.

[0050]

After the spacer 704 is formed, an EL layer 705 and a cathode 706 are formed in succession without breaking a vacuum by an evaporation method. As the EL layer 705, a structure is adopted, in which CuPc (copper phthalocyanine) of 30 nm thickness, TPD (triphenylamine derivative) of 50 nm thickness, and Alq (tris-8-aluminum quinolinolate complex) of 50 nm thickness are laminated from the anode side. However, the layer thickness is not limited to this. Further, an MgAg (an alloy co-evaporated with the ratio of Mg:Ag = 10:1) electrode of 120 nm thickness is used as the cathode 706. Thus, an EL

element emitting green light is formed.

[0051]

Being evaporated using a shadow mask, the EL layer 705 and the cathode 706 can be selectively formed without forming them in unnecessary portions. Further, since the separation of pixels 707 is conducted by the spacer 704 in a pixel portion, the pixels 707 can be integrated with high density. Of course, the EL layers 705 and the cathodes 706 are formed in stripe along the spacers 704 with the direction perpendicular to the paper being the longitudinal direction. Further, with this structure, the cathode 706 is arranged so as to be perpendicular to the anode 702.

[0052]

After the completion through the formation of the cathode 706 without breaking the vacuum, an electrode made of an aluminum film is formed as a protective electrode 708 without further breaking the vacuum. The protective electrode 708 functions as a conductor for uniformly applying a voltage to the cathode 706 while functioning as a protective film for preventing oxidization of the cathode 706. Note that, although not shown in the figure, the protective electrode 708 is electrically connected with the cathode so as to apply the same voltage to all the cathodes, and is drawn out to the portion where an FPC is attached later so as to be applied

with a predetermined voltage.

[0053]

As described above, an EL element is formed on the substrate 601. Next, a cover member 711 is bonded by means of a filler 710 added with a drying agent 709. The bonding apparatus shown in Fig. 4 may be used in this bonding process. Then, a frame member 713 is attached using a sealing member 712 made of an ultraviolet ray curing resin. In this embodiment, a stainless material is used as the frame member 713. Finally, an FPC 714 is attached to complete an EL display device.

[0054]

Note that, since the light emitted from the EL element is radiated to the side opposite to the cover member 711 with the structure of this embodiment, the cover member 711 may have light transmitting property or light shielding property. In this embodiment, a glass plate is used as the cover member 711. However, a plastic plate, a light transmitting substrate such as a PVF film (or a light transmitting film), a ceramics plate, a film in which an aluminum foil is sandwiched by a PVF film, and the like may also be used.

[0055]

[Embodiment 4]

An EL display device formed by implementing the present

invention is of a self light emitting type, and thus, it is excellent in visibility in the light in comparison with a liquid crystal display device, and also has a wide viewing angle. Therefore, the EL display device can be used as a display portion of various electronic devices. For example, the EL display device of the present invention may be used as a display portion of an EL display (a display incorporated with the EL display device in its casing) having a screen size of a 30 inch diagonal or larger (typically a 40 inch diagonal or larger) in order to watch TV broadcasting and the like with a large screen.

[0056]

Note that the EL display includes all displays for displaying information such as a display for a personal computer, a display for receiving TV broadcasting, and a display for displaying an advertisement. Besides, the EL display device of the present invention may be used as a display portion of various electronic devices.

[0057]

As such electronic devices according to the present invention, a video camera, a digital camera, a goggle type display (a head mounted display), a car navigation system, a sound playback device (a car audio system, an audio component stereo or the like), a notebook personal computer, a game

machine, a portable information terminal (a mobile computer, a portable telephone, a portable game machine, an electronic book or the like), an image playback device equipped with a recording medium (specifically, a device which plays a recording medium such as a compact disk (CD), a laser disk (LD), or a digital video disk (DVD) and is equipped with a display that displays the image) and the like can be given. Particularly, a wideness of a viewing angle is regarded as important in the portable information terminal that is often seen from an oblique direction, and thus, the EL display device is desirably used. Specific examples of those electronic devices are shown in Fig. 8.

[0058]

Fig. 8A shows an EL display, which contains a casing 2001, a support stand 2002, a display portion 2003 and the like. The present invention can be applied to the display portion 2003. Since the EL display is of a self light emitting type, it does not need a back light. Thus, the display portion that is thinner than a liquid crystal display can be obtained.

[0059]

Fig. 8B shows a video camera, which contains a main body 2101, a display portion 2102, a sound input portion 2103, operation switches 2104, a battery 2105, an image receiving portion 2106 and the like. The EL display device of the

present invention can be applied to the display portion 2102.

[0060]

Fig. 8C shows a portion (right side) of a head mounted EL display, which contains a main body 2201, signal cables 2202, a head fixing band 2203, a display portion 2204, an optical system 2205, an EL display device 2206 and the like. The present invention can be applied to the EL display device 2206.

[0061]

Fig. 8D shows an image playback device equipped with a recording medium (specifically, a DVD playback device), which contains a main body 2301, a recording medium (such as a CD, an LD, or a DVD) 2302, operation switches 2303, a display portion (a) 2304, a display portion (b) 2305 and the like. The display portion (a) is mainly used for displaying image information. The display portion (b) is mainly used for displaying character information. The present invention can be applied to the display portion (a) and the display portion (b). Note that the image playback device equipped with the recording medium may include devices such as CD playback devices and game machines.

[0062]

Fig. 8E shows a portable (mobile) computer, which contains a main body 2401, a camera portion 2402, an image receiving portion 2403, an operation switch 2404, a display

portion 2405 and the like. The EL display device of the present invention can be applied to the display portion 2405.

[0063]

Fig. 8F shows a personal computer, which contains a main body 2501, a casing 2502, a display portion 2503, a keyboard 2504 and the like. The EL display device of the present invention can be applied to the display portion 2503.

[0064]

Note that, if emission brightness of an EL material is increased in future, it becomes possible to expand and project light including output image information by a lens or the like to be used in a front or rear type projector.

[0065]

Further, the above electronic device displays information distributed through an electronic communication line such as the Internet or a CATV (cable television) in many cases, and in particular, an opportunity of displaying moving image information has been increasing. The response speed of the EL material is very high, and thus, an EL display device is preferable for moving image display. However, if the contour between pixels is blurred, then the entire moving image is also blurred. Therefore, it is very effective to use the EL display device of the present invention, which makes the contour between pixels clear, as a display portion of an

electronic device.

[0066]

Furthermore, in the EL display device, light emitting portions consume electric power, and thus, it is desirable that information is displayed such that the light emitting portions are reduced as much as possible. Therefore, in the case where the EL display device is used for a display portion, which is mainly used for displaying character information, such as that of the portable information terminal, particularly, the portable telephone, or the sound playback device, the EL display device is desirably driven such that character information is formed in the light emitting portions with non-light emitting portions as a background.

[0067]

Fig. 9A shows a portable telephone, which contains a main body 2601, a sound output portion 2602, a sound input portion 2603, a display portion 2604, operation switches 2605, and an antenna 2606. The EL display device of the present invention can be applied to the display portion 2604. Note that white characters are displayed on a black background in the display portion 2604, and thus, power consumption of the portable telephone can be suppressed.

[0068]

Further, Fig. 9B shows a sound playback device,

specifically, a car audio system, which contains a main body 2701, a display portion 2702, and operation switches 2703 and 2704. The EL display device of the present invention can be applied to the display portion 2702. Further, an audio system for loading on a car is shown in this embodiment, but the car audio system may be used for a portable sound playback device. Note that white characters are displayed on a black background in the display portion 2702, and thus, the power consumption can be suppressed. This is particularly effective in the portable sound playback device.

[0069]

As described above, the applicable range of the present invention is extremely wide, and it is possible to apply the present invention to electronic devices in all fields. Further, the electronic device of this embodiment may use the EL display device with any constitution shown in Embodiments 1 to 7.

[0070]

[Effects of the Invention]

The deterioration of the EL element portion of the EL display device can be effectively suppressed by implementing the present invention. Therefore, the EL display device with high reliability can be obtained. Further, such an EL display device with high reliability is used as the display portion of

the electronic device, whereby the reliability of the electronic device can be enhanced.

[Brief Description of the Drawings]

[Figs. 1] Diagrams showing top surface structures of an EL display device.

[Figs. 2] Diagrams showing cross sectional structures of the EL display device.

[Fig. 3] A diagram showing a cross sectional structure of an EL display device.

[Fig. 4] A diagram showing a bonding apparatus of a double vacuum system.

[Fig. 5] A diagram showing a cross sectional structure of an EL display device.

[Fig. 6] A diagram showing a cross sectional structure of an EL display device.

[Fig. 7] A diagram showing a cross sectional structure of an EL display device.

[Figs. 8] Diagrams showing specific examples of electronic devices.

[Figs. 9] Diagram showing specific examples of electronic devices.